Core Content for Science Assessment

The *Core Content for Science Assessment* contains three parts: (1) Conceptual Understandings of Physical, Life, and Earth/Space Science; (2) Scientific Inquiry; and (3) Applications/Connections, the understanding of the nature and utility of science. Thus, all aspects of achievement in science will be assessed. Inquiry and applications/connections skills will be assessed only in the context of physical, Earth/space, and life sciences content.

Test questions will not merely determine whether students have memorized information. They will assess students' understanding and knowledge of science and their ability to reason and use problem-solving skills developed through inquiry and the application of scientific concepts to real-life situations. Elementary students are assessed on their basic understanding of concrete concepts and the simple relationships among them. As students progress from elementary through high school, the concepts studied become more abstract, and students make more connections among concepts. Assessment items reflect this increasing complexity, the expectation of students' deeper understanding of concepts, and the development of sophisticated skills.

Conceptual Understandings

Students need solid knowledge and understanding of physical, life, and Earth/space science concepts if they are to apply science to everyday life. Understanding science implies that students integrate many types of knowledge, including the concepts of science, relationships between concepts, reasons for these relationships, ways to use ideas to explain and predict natural phenomena, and ways to apply ideas. The physical, life, and Earth/space science content statements delineate the content of science in the three widely accepted divisions of science. The content statements focus on science facts, concepts, principles, theories, and models that are important for all students to know, understand, and use.

Scientific Inquiry

Students in all grade levels and domains of science should have the opportunity to use scientific inquiry and develop the ability to think and work as scientists. Scientific inquiry refers to the ways scientists study the natural world and propose explanations based on evidence. Inquiry includes making observations; posing questions; examining sources of information; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating results. Test questions may assess students' understanding of scientific inquiry.

Applications/Connections

The Applications/Connections part is organized into three categories. Science and technology includes a study of the abilities associated with technological design, the similarities between inquiry and technological design, and the idea that technological solutions have benefits and consequences. Science in personal and social perspectives includes a study of the concepts of population growth; natural resources; environmental quality; and natural and human-induced hazards. History and nature of science includes a study of the concepts of science as a human endeavor, the nature of scientific knowledge, and historical perspectives of science.

Core Content for Science Assessment

Test items that show connections to science and technology may include examples of how technological advances contribute to the advancement of scientific theories and concepts. Questions may assess students' understanding of how science is continuously revised and evaluated by society and the reciprocity between science and technology. Test items may reflect personal and social perspectives such as students' understanding of relationships among populations within communities or the interactions among people, society, and scientific challenges. Test items may also show connections to historical or cultural perspectives of science. Students' understanding of the human dimensions of science, the nature of scientific knowledge, and the role of science in society may be assessed.

Codes

The code numbers that are listed before each content statement are used to identify, track, and collect data on questions for the state assessment system. The following abbreviations are used in the codes:

- SC - Science
- E - Elementary Level, Grades P-4
- M - Middle Level, Grades 5-7
- H - High School, Grades 8-11

The first number in the coding sequence identifies the subdomain of science: 1 stands for physical science, 2 stands for Earth/space science, and 3 stands for life science. The second number in the coding sequence identifies the section title of the core content (e.g., Transfer of Energy, Position and Motion of Objects). The third number in the coding sequence identifies the content statement. For example, in the coding sequence "SC-M-1.3.2", SC stands for science, M stands for middle level, 1 stands for the physical science subdomain, 3 stands for the section "Transfer of Energy, " and 2 stands for the content statement that begins "Heat energy moves in...."

Core Content for Science Assessment
Grades Primary through 4 with Assessment at Grade 4
Conceptual Understandings: Physical Science

Academic Expectations: 2.2 Patterns of Change, 2.3 Systems, 2.4 Scale and Models, 2.5 Constancy, and 2.6 Change Over Time

Content Statements

Properties of Objects and Materials

SC-E-1.1.1 Objects have many observable properties such as size, mass, shape, color, temperature, magnetism, and the ability to react with other substances. Some properties can be measured using tools such as metric rulers, balances, and thermometers.

SC-E-1.1.2 Objects are made of one or more materials such as paper, wood, and metal. Objects can be described by the properties of the materials from which they are made. Those properties can be used to separate or classify objects or materials.

SC-E-1.1.3 Materials can exist in different states--solid, liquid, and gas. Some common materials, such as water, can be changed from one state to another by heating or cooling.

Position and Motion of Objects

SC-E-1.2.1 The position of an object can be described by locating it relative to another object or the background. The position can be described using phrases such as to the right, to the left, 50 cm from the other object.

SC-E-1.2.2 An object's motion can be described by measuring its change in position over time such as rolling different objects (e.g., spheres, toy cars) down a ramp.

SC-E-1.2.3 The position and motion of objects can be changed by pushing or pulling. The amount of change in position and motion is related to the strength of the push or pull (force). The force with which a ball is hit illustrates this principle.

SC-E-1.2.4 Vibration is a type of motion. Sound is produced by vibrating objects. The pitch of the sound can be varied by changing the rate of vibration.

Core Content for Science Assessment
Grades Primary through 4 with Assessment at Grade 4

Conceptual Understandings: Physical Science

Academic Expectations: 2.2 Patterns of Change, 2.3 Systems, 2.4 Scale and Models, 2.5 Constancy, and 2.6 Change Over Time

Content Statements

Light, Heat, Electricity, and Magnetism

SC-E-1.3.1 Light travels in a straight line until it strikes an object. Light can be reflected by a shiny object (e.g., mirror, spoon), refracted by a lens (e.g., magnifying glass, eyeglasses), or absorbed by an object (e.g., dark surface).

SC-E-1.3.2 Heat can be produced in many ways such as burning or rubbing. One way heat can move from one object to another is by conduction. Some materials absorb and conduct heat better than others. For example, metal objects conduct heat better than wooden objects.

SC-E-1.3.3 Electricity in circuits can produce light, heat, sound, and magnetic effects. Electrical circuits require a complete conducting path through which an electrical current can pass.

SC-E-1.3.4 Magnets attract and repel each other, and magnets attract certain kinds of other materials (e.g., iron).

Conceptual Understandings: Earth and Space Science

Academic Expectations: 2.2 Patterns of Change, 2.3 Systems, 2.4 Scale and Models, 2.5 Constancy, and 2.6 Change Over Time

Content Statements

Properties of Earth Materials

SC-E-2.1.1 Earth materials include solid rocks and soils, water, and the gases of the atmosphere. Minerals that make up rocks have properties of color, texture, and hardness. Soils have properties of color, texture, the capacity to retain water, and the ability to support plant growth. Water on Earth and in the atmosphere can be a solid, liquid, or gas.

SC-E-2.1.2 Earth materials provide many of the resources humans use. The varied materials have different physical and chemical properties, which make them useful in different ways, for example, as building materials (e.g., stone, clay, marble), as sources of fuel (e.g., petroleum, natural gas), or growing the plants we use as food.

SC-E-2.1.3 Fossils found in Earth materials provide evidence about organisms that lived long ago and the nature of the environment at that time.

Objects in the Sky

SC-E-2.2.1 The Sun provides the light and heat necessary to maintain the temperature of Earth. The Sun's light and heat are necessary to sustain life on Earth.

SC-E-2.2.2 Objects in the sky (e.g., Sun, clouds, moon) have properties, locations, and real or apparent movements that can be observed and described.

Changes in Earth and Sky

SC-E-2.3.1 The surface of the Earth changes. Some changes are due to slow processes such as erosion or weathering. Some changes are due to rapid processes such as landslides, volcanic eruptions, and earthquakes.

SC-E-2.3.2 Weather changes from day to day and over seasons. Weather can be described by observations and measurable quantities such as temperature, wind direction and speed, and precipitation.

SC-E-2.3.3 Changes in movement of objects in the sky have patterns that can be observed and described. The Sun appears to move across the sky in the same way every day, but the Sun's apparent path changes slowly over seasons. The moon moves across the sky on a daily basis much like the Sun. The observable shape of the moon changes from day to day in a cycle that lasts about a month.

Conceptual Understandings: Life Science

Academic Expectations: 2.2 Patterns of Change, 2.3 Systems, 2.4 Scale and Models, 2.5 Constancy, and 2.6 Change Over Time

Content Statements

The Characteristics of Organisms

SC-E-3.1.1 Things in the environment are classified as living, nonliving, and once living. Living things differ from nonliving things. Organisms are classified into groups by using various characteristics (e.g., body coverings, body structures).

SC-E-3.1.2 Organisms have basic needs. For example, animals need air, water, and food; plants need air, water, nutrients, and light. Organisms can survive only in environments in which their needs can be met.

SC-E-3.1.3 Each plant or animal has structures that serve different functions in growth, survival, and reproduction. For example, humans have distinct body structures for walking, holding, seeing, and talking.

Life Cycles of Organisms

SC-E-3.2.1 Plants and animals have life cycles that include the beginning of life, growth and development, reproduction, and death. The details of a life cycle are different for different organisms.

SC-E-3.2.2 Plants and animals closely resemble their parents at some time in their life cycle. Some characteristics (e.g., the color of flowers, the number of appendages) are passed to offspring. Other characteristics are learned from interactions with the environment such as the ability to ride a bicycle, and these cannot be passed on to the next generation.

Organisms and Their Environments

SC-E-3.3.1 Plants make their own food. All animals depend on plants. Some animals eat plants for food. Other animals eat animals that eat the plants.

SC-E-3.3.2 The world has many different environments. Distinct environments support the lives of different types of organisms. When the environment changes, some plants and animals survive and reproduce, and others die or move to new locations.

SC-E-3.3.3 All organisms, including humans, cause changes in the environment where they live. Some of these changes are detrimental to the organism or to other organisms; other changes are beneficial (e.g., dams built by beavers benefit some aquatic organisms but are detrimental to others).

Scientific Inquiry

Inquiry skills will be assessed only in the context of physical, Earth/space, and life sciences content.

Academic Expectation: 2.1 Scientific Ways of Thinking and Working

Content Statements

Students will

- ask simple scientific questions that can be investigated through observations combined with scientific information.
- use simple equipment (e.g., magnifiers, magnets), tools (e.g., metric rulers, thermometers), skills (e.g., classifying, predicting), technology (e.g., electronic media, calculators, World Wide Web), and mathematics in scientific investigations.
- use evidence (e.g., observations, data) from simple scientific investigations and scientific knowledge to develop reasonable explanations.
- design and conduct simple scientific investigations.
- communicate (e.g., draw, graph, write) designs, procedures, observations, and results of scientific investigations.
- review and ask questions about scientific investigations and explanations of other students.

Applications/Connections

Applications/connections skills will be assessed only in the context of physical, Earth/space, and life sciences content.

Academic Expectations: 2.2 Patterns of Change, 2.3 Systems, 2.4 Scale and Models, 2.5 Constancy, and 2.6 Change Over Time

Content Statements

Students will

Science and Technology

- distinguish between natural objects and objects made by humans and examine the interaction between science and technology. Technology (e.g., thermometer, hand lens) is used to study science, while science provides theories for technology. Science is used to design simple technological solutions to problems (e.g., use understanding of heat transfer in designing an insulated container for ice cubes).

Science in Personal and Social Perspectives

- examine how designing and conducting scientific investigations fosters an understanding of issues related to natural resources (e.g., scarcity), demonstrate how the study of science (e.g., aquariums, living systems) helps explain changes in environments, and examine the role of science and technology in communities (e.g., location of landfills, new housing developments).

History and Nature of Science

- examine the role science plays in everyday life.

Conceptual Understandings: Physical Science

Academic Expectations: 2.2 Patterns of Change, 2.3 Systems, 2.4 Scale and Models, 2.5 Constancy, and 2.6 Change Over Time

Content Statements

Properties and Changes of Properties in Matter

SC-M-1.1.1 A substance has characteristic physical properties (e.g., density, boiling point, solubility) that are independent of the amount of the sample. A mixture of substances often can be separated into the original substances by using one or more of these characteristic physical properties.

SC-M-1.1.2 The chemical properties of a substance cause it to react in predictable ways with other substances to form compounds with different characteristic properties. In chemical reactions, the total mass is conserved. Substances are often classified into groups if they react in similar ways.

SC-M-1.1.3 Chemical elements do not break down during normal laboratory reactions such as heating, exposure to electric currents, or reaction with acids. Elements combine in many ways to produce compounds.

Motions and Forces

SC-M-1.2.1 The motion of an object can be described by its relative position, direction of motion, and speed. That motion can be measured and represented on a graph.

SC-M-1.2.2 An object remains at rest or maintains a constant speed and direction of motion unless an unbalanced force acts on it.

SC-M-1.2.3 When an unbalanced force acts on an object, the change in speed and/or direction depends on the size and direction of the force.

Transfer of Energy

SC-M-1.3.1 Energy is a property of many substances and is associated with heat, light, electricity, and sound. Energy is transferred in many ways.

SC-M-1.3.2 Heat energy moves in predictable ways, flowing from warmer objects to cooler ones, until both objects reach the same temperature.

SC-M-1.3.3 Light energy interacts with matter by transmission (including refraction), absorption, or scattering (including reflection).

SC-M-1.3.4 The Sun is a major source of energy for changes on Earth’s surface. The Sun loses energy by emitting light. A tiny fraction of that light reaches Earth, transferring energy from the Sun to Earth.

SC-M-1.3.5 Electrical circuits provide a means of transferring electrical energy when heat, light, sound, and chemical changes are produced.

Conceptual Understandings: Earth and Space Science

Academic Expectations: 2.2 Patterns of Change, 2.3 Systems, 2.4 Scale and Models, 2.5 Constancy, and 2.6 Change Over Time

Content Statements

Structure of the Earth System: Lithosphere, Hydrosphere, Atmosphere

SC-M-2.1.1 The Earth is layered. The lithosphere is the thin crust of the Earth. Lithospheric plates move slowly in response to movements in the mantle. There is a dense core at the center of the Earth.

SC-M-2.1.2 Landforms are a result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruption, and deposition of sediment, while destructive forces include weathering and erosion.

SC-M-2.1.3 Materials found in the lithosphere and mantle are changed in a continuous process called the rock cycle.

SC-M-2.1.4 Soil consists of weathered rocks and decomposed organic material from dead plants, animals, fungi, protists, and bacteria. Soils are often found in layers, with each having a different chemical composition and texture.

SC-M-2.1.5 Water, which covers the majority of the Earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the water cycle. Water dissolves minerals and gases and may carry them to the oceans.

SC-M-2.1.6 Earth is surrounded by a relatively thin blanket of air called the atmosphere. The atmosphere is a mixture of nitrogen, oxygen, and trace gases that include water vapor. The atmosphere has different properties at different elevations.

SC-M-2.1.7 Global patterns of atmospheric movement influence local weather. Oceans have a major effect on climate, because water in the oceans holds a large amount of heat.

Earth's History

SC-M-2.2.1 The Earth's processes we see today, including erosion, movement of lithospheric plates, and changes in atmospheric composition, are similar to those that occurred in the past. Earth's history is also influenced by occasional catastrophes such as the impact of an asteroid or comet.

SC-M-2.2.2 Fossils provide important evidence of how environmental conditions and life have changed.

Conceptual Understandings: Earth and Space Science

Academic Expectations: 2.2 Patterns of Change, 2.3 Systems, 2.4 Scale and Models, 2.5 Constancy, and 2.6 Change Over Time

Content Statements

Earth in the Solar System

SC-M-2.3.1 Earth is the third planet from the Sun in a system that includes the moon, the Sun, eight other planets and their moons, and smaller objects such as asteroids and comets. The Sun, an average star, is the central and largest body in the solar system.

SC-M-2.3.2 Most objects in the solar system are in regular and predictable motion. Those motions explain such phenomena as the day, the year, phases of the moon, and eclipses.

SC-M-2.3.3 Gravity is the force that keeps the planets in orbit around the Sun and governs the rest of the motion in the solar system. The gravitational pull of the Sun and moon on Earth's oceans is the major cause of tides.

SC-M-2.3.4 The Sun is the major source of energy for Earth. The water cycle, winds, ocean currents, and growth of plants are affected by the Sun's energy. Seasons result from variations in the amount of the Sun's energy hitting Earth's surface.

Core Content for Science Assessment
Grades 5 through 7 with Assessment at Grade 7

Conceptual Understandings: Life Science

Academic Expectations: 2.2 Patterns of Change, 2.3 Systems, 2.4 Scale and Models, 2.5 Constancy, and 2.6 Change Over Time

Content Statements

Structure and Function in Living Systems

SC-M-3.1.1 Living systems at all levels of organization demonstrate the complementary nature of structure and function. Important levels of organization for structure and function include cells, tissues, organs, organ systems, organisms (e.g., bacteria, protists, fungi, plants, animals), and ecosystems.

SC-M-3.1.2 All organisms are composed of cells, the fundamental unit of life. Most organisms are single cells; other organisms, including plants and animals are multicellular.

SC-M-3.1.3 Cells carry on the many functions needed to sustain life. They grow and divide, thereby producing more cells. This requires that they take in nutrients, which they use to provide energy for the work that cells do and to make the materials that a cell or an organism needs.

SC-M-3.1.4 Specialized cells perform specialized functions in multicellular organisms. Groups of specialized cells cooperate to form tissues. Different tissues are, in turn, grouped together to form larger functional units called organs. Each type of cell, tissue, and organ has a distinct structure and set of functions that serve the organism.

Regulation and Behavior

SC-M-3.2.1 All organisms must be able to obtain and use resources, grow, reproduce, and maintain stable internal conditions while living in a constantly changing external environment.

SC-M-3.2.2 Regulation of an organism's internal environment involves sensing the internal environment and changing physiological activities to keep conditions within the range required to survive. Maintaining a stable internal environment is essential for an organism's survival.

SC-M-3.2.3 Behavior is one kind of response an organism may make to an internal or environmental stimulus. A behavioral response requires coordination and communication at many levels including cells, organ systems, and organisms. Behavioral response is a set of actions determined in part by heredity and in part from experience.

Core Content for Science Assessment
Grades 5 through 7 with Assessment at Grade 7

Conceptual Understandings: Life Science

Academic Expectations: 2.2 Patterns of Change, 2.3 Systems, 2.4 Scale and Models, 2.5 Constancy, and 2.6 Change Over Time

Content Statements

Reproduction and Heredity

SC-M-3.3.1 Reproduction is a characteristic of all living systems and is essential to the continuation of every species. Some organisms reproduce asexually, others reproduce sexually. In species that reproduce sexually, including humans and plants, male and female sex cells carrying genetic information unite to begin the development of a new individual.

SC-M-3.3.2 Every organism requires a set of instructions for specifying its traits. This information is contained in genes located in the chromosomes of each cell. Heredity is the passage of these instructions from one generation to another.

Diversity and Adaptations of Organisms

SC-M-3.4.1 Biological change over time accounts for the diversity of species developed through gradual processes over many generations. Biological adaptations include changes in structures, behaviors, or physiology that enhance survival and reproductive success in a particular environment.

SC-M-3.4.2 Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival. Extinction of species is common; most of the species that have lived on Earth no longer exist.

Populations and Ecosystems

SC-M-3.5.1 A population consists of all individuals of a species that occur together at a given place and time. All populations living together and the physical factors with which they interact compose an ecosystem.

SC-M-3.5.2 Populations of organisms can be categorized by the function they serve in an ecosystem. Plants and some microorganisms are producers because they make their own food. All animals, including humans, are consumers, and obtain their food by eating other organisms. Decomposers, primarily bacteria and fungi, are consumers that use waste materials and dead organisms for food. Food webs identify the relationships among producers, consumers, and decomposers in an ecosystem.

SC-M-3.5.3 For most ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis. That energy then passes from organism to organism in food webs.

SC-M-3.5.4 The number of organisms an ecosystem can support depends on the resources available and abiotic factors (e.g., quantity of light and water, range of temperatures, soil composition). Given adequate biotic and abiotic resources and no diseases or predators, populations (including humans) increase at rapid rates. Lack of resources and other factors, such as predation and climate, limit the growth of populations in specific niches in the ecosystem.

Core Content for Science Assessment
Grades 5 through 7 with Assessment at Grade 7

Scientific Inquiry

Inquiry skills will be assessed only in the context of physical, Earth/space, and life sciences content.

Academic Expectation: 2.1 Scientific Ways of Thinking and Working

Content Statements

Students will

- refine and refocus questions that can be answered through scientific investigation combined with scientific information.
- use appropriate equipment, tools, techniques, technology, and mathematics to gather, analyze, and interpret scientific data.
- use evidence (e.g., computer models), logic, and scientific knowledge to develop scientific explanations.
- design and conduct scientific investigations.
- communicate (e.g., write, graph) designs, procedures, observations, and results of scientific investigations.
- review and analyze scientific investigations and explanations of other students.

Applications/Connections

Applications/connections skills will be assessed only in the context of physical, Earth/space, and life sciences content.

Academic Expectations: 2.2 Patterns of Change, 2.3 Systems, 2.4 Scale and Models, 2.5 Constancy, and 2.6 Change Over Time

Content Statements

Students will

Science and Technology

- describe how science helps drive technology and technology helps drive science. Because perfectly designed solutions do not exist, technological solutions have intended benefits and unintended consequences.

Science in Personal and Social Perspectives

- describe the individual's roles and responsibilities in the following areas: changes in populations, resources and environments including ecological crises and environmental issues, natural hazards, science and technology in society, and personal and societal issues about risks and benefits.

History and Nature of Science

- demonstrate the role science plays in everyday life: past, present, and future. Science is a human endeavor. Men and women of various social and ethnic backgrounds engage in activities of science (to include careers in science). Scientists formulate and test their explanations of nature using observations, experiments, and theoretical and mathematical models. It is part of scientific inquiry to evaluate the results of scientific investigations, experiments, observations, theoretical models, and the explanations proposed by other scientists.

Conceptual Understandings: Physical Science

Academic Expectations: 2.2 Patterns of Change, 2.3 Systems, 2.4 Scale and Models, 2.5 Constancy, and 2.6 Change Over Time

Content Statements

Structure of Atoms

SC-H-1.1.1 Matter is made of minute particles called atoms, and atoms are composed of even smaller components. The components of an atom have measurable properties such as mass and electrical charge. Each atom has a positively charged nucleus surrounded by negatively charged electrons. The electric force between the nucleus and the electrons holds the atom together.

SC-H-1.1.2 The atom's nucleus is composed of protons and neutrons that are much more massive than electrons. When an element has atoms that differ in the number of neutrons, these atoms are called different isotopes of the element.

SC-H-1.1.3 The forces that hold the nucleus together, at nuclear distances, are usually stronger than the forces that would make it fly apart. Nuclear reactions convert a fraction of the mass of interacting particles into energy, and they can release much greater amounts of energy than atomic interactions. Fission is the splitting of a large nucleus into smaller pieces. Fusion is the joining of two nuclei at extremely high temperature and pressure. Fusion is the process responsible for the energy of the Sun and other stars.

Structure and Properties of Matter

SC-H-1.2.1 Atoms interact with each other by transferring or sharing outermost electrons. These outer electrons govern the chemical properties of the element.

SC-H-1.2.2 An element is composed of a single type of atom. When elements are listed according to the number of protons, repeating patterns of physical and chemical properties identify families of elements with similar properties. The periodic table is a consequence of the repeating pattern of outermost electrons.

SC-H-1.2.3 Bonds between atoms are created when outer electrons are paired by being transferred or shared. A compound is formed when two or more kinds of atoms bind together chemically.

SC-H-1.2.4 The physical properties of compounds reflect the nature of the interactions among molecules. These interactions are determined by the structure of the molecule including the constituent atoms.

SC-H-1.2.5 Solids, liquids, and gases differ in the distances between molecules or atoms and therefore the energy that binds them together. In solids, the structure is nearly rigid; in liquids, molecules or atoms move around each other but do not move apart; and in gases, molecules or atoms move almost independently of each other and are relatively far apart.

SC-H-1.2.6 In conducting materials, electrons flow easily; whereas, in insulating materials, they can hardly flow at all. Semiconducting materials have intermediate behavior. At low temperatures, some materials become superconductors and offer no resistance to the flow of electrons.

Conceptual Understandings: Physical Science

Academic Expectations: 2.2 Patterns of Change, 2.3 Systems, 2.4 Scale and Models, 2.5 Constancy, and 2.6 Change Over Time

Content Statements

Chemical Reactions

SC-H-1.3.1 Chemical reactions occur all around us and in every cell in our bodies. These reactions may release or consume energy. Rates of chemical reactions vary. Reaction rates depend on concentration, temperature, and properties of reactants. Catalysts speed up chemical reactions.

Motions and Forces

SC-H-1.4.1 Objects change their motion only when a net force is applied. Laws of motion are used to describe the effects of forces on the motion of objects.

SC-H-1.4.2 Gravity is a universal force that each mass exerts on every other mass.

SC-H-1.4.3 The electric force is a universal force that exists between any two charged objects. Opposite charges attract while like charges repel.

SC-H-1.4.4 Electricity and magnetism are two aspects of a single electromagnetic force. Moving electric charges produce magnetic forces, and moving magnets produce electric forces. This idea underlies the operation of electric motors and generators.

Conservation of Energy and Increase in Disorder

SC-H-1.5.1 The total energy of the universe is constant. Energy can be transferred in many ways, but it can neither be created nor destroyed.

SC-H-1.5.2 All energy can be considered to be either kinetic energy, potential energy, or energy contained by a field (e.g., electric, magnetic, gravitational).

SC-H-1.5.3 Heat is the manifestation of the random motion and vibrations of atoms, molecules, and ions. The greater the atomic or molecular motion, the higher the temperature.

SC-H-1.5.4 The universe becomes less orderly and less organized over time. Thus, the overall effect is that the energy is spread out uniformly. For example, in the operation of mechanical systems, the useful energy output is always less than the energy input; the difference appears as heat.

Conceptual Understandings: Physical Science

Academic Expectations: 2.2 Patterns of Change, 2.3 Systems, 2.4 Scale and Models, 2.5 Constancy, and 2.6 Change Over Time

Content Statements

Interactions of Energy and Matter

SC-H-1.6.1 Waves, including sound and seismic waves, waves on water, and electromagnetic waves, can transfer energy when they interact with matter. Apparent changes in frequency can provide information about relative motion.

SC-H-1.6.2 Electromagnetic waves, including radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, x-rays, and gamma rays, result when a charged object is accelerated.

Conceptual Understandings: Earth and Space Science

Academic Expectations: 2.2 Patterns of Change, 2.3 Systems, 2.4 Scale and Models, 2.5 Constancy, and 2.6 Change Over Time

Content Statements

Energy in the Earth System

SC-H-2.1.1 Earth systems have sources of energy that are internal and external to the Earth. The Sun is the major external source of energy. Two primary sources of internal energy are the decay of radioactive isotopes and the gravitational energy from Earth's original formation.

SC-H-2.1.2 The outward transfer of Earth's internal heat drives convection circulation in the mantle. This causes the crustal plates to move on the face of the Earth.

SC-H-2.1.3 Heating of Earth's surface and atmosphere by the Sun drives convection within the atmosphere and oceans, producing winds and ocean currents.

SC-H-2.1.4 Global climate is determined by energy transfer from the Sun at and near Earth's surface. This energy transfer is influenced by dynamic processes such as cloud cover and the Earth's rotation and static conditions such as the position of mountain ranges and oceans.

Geochemical Cycles

SC-H-2.2.1 Earth is a system containing essentially a fixed amount of each stable chemical atom or element. Each element can exist in several different reservoirs. Each element on Earth moves among reservoirs in the solid Earth, oceans, atmosphere, and organisms as part of geochemical cycles.

SC-H-2.2.2 Movement of matter between reservoirs is driven by Earth's internal and external sources of energy. These movements are often accompanied by a change in physical and chemical properties of the matter. Carbon, for example, occurs in carbonate rocks such as limestone, in the atmosphere as carbon dioxide gas, in water as dissolved carbon dioxide, and in all organisms as complex molecules that control the chemistry of life.

Conceptual Understandings: Earth and Space Science

Academic Expectations: 2.2 Patterns of Change, 2.3 Systems, 2.4 Scale and Models, 2.5 Constancy, and 2.6 Change Over Time

Content Statements

The Formation and Ongoing Changes of the Earth System

SC-H-2.3.1 The Sun, Earth, and the rest of the solar system formed approximately 4.6 billion years ago from a nebular cloud of dust and gas.

SC-H-2.3.2 Techniques used to estimate geological time include using radioactive dating, observing rock sequences, and comparing fossils to correlate the rock sequences at various locations.

SC-H-2.3.3 Interactions among the solid Earth, the oceans, the atmosphere, and living things have resulted in the ongoing development of a changing Earth system. Earthquakes and volcanic eruptions can be observed on a human time scale, but many processes, such as mountain building and plate movements, take place over hundreds of millions of years.

SC-H-2.3.4 Evidence for one-celled forms of life, the bacteria, extends back more than 3.5 billion years. The changes in life over time caused dramatic changes in the composition of the Earth's atmosphere, which did not originally contain oxygen.

The Formation and Ongoing Changes of the Universe

SC-H-2.4.1 The big bang theory and observational measurements that support it place the origin of the universe at a time between 10 and 20 billion years ago, when the universe began in a hot dense state. According to this theory, the universe has been expanding since then.

SC-H-2.4.2 Early in the history of the universe, the first atoms to form were mainly hydrogen and helium. Over time, these elements clump together by gravitational attraction to form trillions of stars.

SC-H-2.4.3 Stars have life cycles of birth through death that are analogous to those of living organisms. During their lifetimes, stars generate energy from nuclear fusion reactions that create successively heavier chemical elements. Some stars explode at the end of their lives, and the heavy elements they have created are blasted out into space to form the next generation of stars and planets.

Conceptual Understandings: Life Science

Academic Expectations: 2.2 Patterns of Change, 2.3 Systems, 2.4 Scale and Models, 2.5 Constancy, and 2.6 Change Over Time

Content Statements

The Cell

SC-H-3.1.1 Cells have particular structures that underlie their function. Every cell is surrounded by a membrane that separates it from the outside world. Inside the cell is a concentrated mixture of thousands of different molecules that form a variety of specialized structures. These structures carry out specific cell functions.

SC-H-3.1.2 Most cell functions involve chemical reactions. Food molecules taken into cells react to provide the chemical constituents needed to synthesize other molecules. Both breakdown and synthesis are made possible by a large set of protein catalysts, called enzymes. The breakdown of some of the food molecules enables the cell to store energy in specific chemicals that are used to carry out the many functions of the cell.

SC-H-3.1.3 Cells store and use information to guide their functions. The genetic information stored in DNA directs the synthesis of the thousands of proteins that each cell requires.

SC-H-3.1.4 Cell functions are regulated. Regulation occurs both through changes in the activity of the functions performed by proteins and through selective expression of individual genes. This regulation allows cells to respond to their internal and external environments and to control and coordinate cell growth and division.

SC-H-3.1.5 Plant cells contain chloroplasts, the site of photosynthesis. Plants and many microorganisms (e.g., *Euglena*) use solar energy to combine molecules of carbon dioxide and water into complex, energy-rich organic compounds and release oxygen to the environment. This process of photosynthesis provides a vital link between the Sun and energy needs of living systems.

SC-H-3.1.6 In the development of multicellular organisms, cells multiply and differentiate to form many specialized cells, tissues, and organs. This differentiation is regulated through the expression of different genes.

Conceptual Understandings: Life Science

Academic Expectations: 2.2 Patterns of Change, 2.3 Systems, 2.4 Scale and Models, 2.5 Constancy, and 2.6 Change Over Time

Content Statements

The Behavior of Organisms

SC-H-3.2.1 Multicellular animals have nervous systems that generate behavior. Nerve cells communicate with each other by secreting specific molecules. Specialized cells in sense organs detect light, sound, and specific chemicals enabling animals to monitor what is going on in the world around them.

SC-H-3.2.2 Behavioral responses to internal changes and external stimuli can be innate or learned. Responses to external stimuli can result from interactions with the organism's own species and/or other species, as well as environmental changes.

SC-H-3.2.3 The broad patterns of behavior exhibited by organisms have changed over time through natural selection to ensure reproductive success. Organisms often live in unpredictable environments, so their behavioral responses must be flexible enough to deal with uncertainty and change. Behaviors often have an adaptive logic.

The Molecular Basis of Heredity

SC-H-3.3.1 In all organisms and viruses, the instructions for specifying the characteristics are carried in nucleic acids. The chemical and structural properties of nucleic acids determine how the genetic information that underlies heredity is both encoded in genes and replicated.

SC-H-3.3.2 Multicellular organisms, including humans, form from cells that contain two copies of each chromosome. This explains many features of heredity. Transmission of genetic information through sexual reproduction to offspring occurs when male and female gametes that contain only one representative from each chromosome pair unite.

SC-H-3.3.3 Changes in DNA (mutations) occur spontaneously at low rates. Some of these changes make no difference to the organism, whereas others can change cells and organisms. Only mutations in germ cells have the potential to create the variation that changes an organism's future offspring.

Conceptual Understandings: Life Science

Academic Expectations: 2.2 Patterns of Change, 2.3 Systems, 2.4 Scale and Models, 2.5 Constancy, and 2.6 Change Over Time

Content Statements

Biological Change

SC-H-3.4.1 Species change over time. Biological change over time is the consequence of the interactions of (1) the potential for a species to increase its numbers, (2) the genetic variability of offspring due to mutation and recombination of genes, (3) a finite supply of the resources required for life, and (4) natural selection. The consequences of change over time provide a scientific explanation for the fossil record of ancient life forms and for the striking molecular similarities observed among the diverse species of living organisms.

SC-H-3.4.2 The great diversity of organisms is the result of more than 3.5 billion years of biological change over time that has filled every available niche with life forms. The millions of different species of plants, animals, and microorganisms that live on Earth today are related by descent from common ancestors.

SC-H-3.4.3 Biological classifications are based on how organisms are related. Organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their relationships. Species is the most fundamental unit of classification. Different species are classified by the comparison and analysis of their internal and external structures and the similarity of their chemical processes.

The Interdependence of Organisms

SC-H-3.5.1 Atoms (e.g., carbon, nitrogen) and molecules (e.g., water) cycle among the living and nonliving components of the biosphere.

SC-H-3.5.2 Energy flows through ecosystems in one direction from photosynthetic organisms to herbivores to carnivores and decomposers.

SC-H-3.5.3 Organisms both cooperate and compete in ecosystems. Often changes in one component of an ecosystem will have effects on the entire system that are difficult to predict. The interrelationships and interdependencies of these organisms may generate ecosystems that are stable for hundreds or thousands of years.

Conceptual Understandings: Life Science

Academic Expectations: 2.2 Patterns of Change, 2.3 Systems, 2.4 Scale and Models, 2.5 Constancy, and 2.6 Change Over Time

Content Statements

The Interdependence of Organisms (continued)

SC-H-3.5.4 Living organisms have the capacity to produce populations of infinite size. However, behaviors, environments, and resources influence the size of populations. Models (e.g., mathematical, physical, conceptual) can be used to make predictions about changes in the size or rate of growth of a population.

SC-H-3.5.5 Human beings live within the world's ecosystems. Human activities can deliberately or inadvertently alter the dynamics in ecosystems. These activities can threaten current and future global stability and, if not addressed, ecosystems can be irreversibly affected.

Matter, Energy, and Organization in Living Systems

SC-H-3.6.1 Living systems require a continuous input of energy to maintain their chemical and physical organization since the universal tendency is toward more disorganized states. The energy for life primarily derives from the Sun. Plants capture energy by absorbing light and using it to form strong (covalent) chemical bonds between the atoms of carbon-containing molecules. These molecules can be used to assemble larger molecules (e.g., DNA, proteins, sugars, fats). In addition, the energy stored in the bonds between the atoms can be used as sources of energy for life processes.

SC-H-3.6.2 The chemical bonds of food molecules contain energy. Energy is released when the bonds of food molecules are broken and new compounds with lower energy bonds are formed. Cells usually store this energy temporarily in the phosphate bonds of ATP. During the process of cellular respiration, some energy is lost as heat.

SC-H-3.6.3 As matter and energy flow through different organizational levels (e.g., cells, organs, organisms, communities) and between living systems and the physical environment, chemical elements are recombined in different ways. Each recombination results in storage and dissipation of energy into the environment as heat. Matter and energy are conserved in each change.

Scientific Inquiry

Inquiry skills will be assessed only in the context of physical, Earth/space, and life sciences content.

Academic Expectation: 2.1 Scientific Ways of Thinking and Working

Content Statements

Students will

- formulate testable hypotheses and demonstrate the logical connections between the scientific concepts guiding a hypothesis and the design of an experiment.
- use equipment, tools, techniques, technology, and mathematics to improve scientific investigations and communications.
- use evidence, logic, and scientific knowledge to develop and revise scientific explanations and models.
- design and conduct different kinds of scientific investigations.
- communicate and defend the designs, procedures, observations, and results of scientific investigations.
- review and analyze scientific investigations and explanations of other investigators, including peers.

Applications/Connections

Applications/connections skills will be assessed only in the context of physical, Earth/space, and life sciences content.

Academic Expectations: 2.2 Patterns of Change, 2.3 Systems, 2.4 Scale and Models, 2.5 Constancy, and 2.6 Change Over Time

Content Statements

Students will

Science and Technology

- apply scientific theory and conceptual understandings to solve problems of technological design and examine the interaction between science and technology.

Personal and Social Perspectives

- explore the impact of scientific knowledge and discoveries on personal and community health; recognize how science influences human population growth, use science to analyze the use of natural resources by an increasing human population; investigate how science can be used to solve environmental quality problems, use science to investigate natural and human-induced hazards; and analyze how science and technology are necessary but not sufficient for solving local, national, and global issues.

d Nature of Science

- analyze the role science plays in everyday life and compare different careers in science; recognize that scientific knowledge comes from empirical standards, logical arguments, and skepticism, and is subject to change as new evidence becomes available; and investigate advances in science and technology that have important and long-lasting effects on science and society.